PROC. ENTOMOL. SOC. WASH.
100(3), 1998, pp. 511–520

IMMATURE LIFE STAGE DESCRIPTIONS AND DISTRIBUTION OF *CULOPTILA CANTHA* (ROSS) (TRICHOPTERA: GLOSSOSOMATIDAE)

David C. Houghton and Kenneth W. Stewart

Department of Biological Sciences, University of North Texas, Denton, TX 76203, U.S.A.; (DCH) Current address: Department of Entomology, 219 Hodson Hall, 1980 Folwell Avenue, University of Minnesota, Saint Paul, MN 55108, U.S.A. (e-mail: hough005@tc.umn.edu).

Abstract.—The eggs, larvae of all instars, larval cases, and pupae of *Culoptila cantha* (Ross) are described for the first time. The distribution of the species is provided.

Key Words: *Culoptila*, Glossosomatidae, Trichoptera, eggs, larvae, pupae, cases, descriptions, distribution

The primarily Neotropical glossosomatid genus *Culoptila* Mosely contains 17 species from the new world (Morse, in prep.) including four from the United States: *C. cantha* (Ross), *C. thoracica* (Ross), *C. kimminsi* Denning, and *C. moselyi* Denning. All four are found in the Southwest, and *C. cantha* and *C. thoracica* are also recorded from the East (Flint 1974).

Wiggins (1977, 1996a) provided the only illustration of a *Culoptila* larva, *C. moselyi*, and indicated that its cases are composed of small uniform rock fragments with partial silk collars on the periphery. There have been no reported correlations or descriptions of the larvae or cases of the other three North American species, or of any *Culoptila* pupa.

Materials and Methods

Specimens of *C. cantha* came primarily from a large riffle of the Brazos River located approximately 35 km below Morris Sheppard Dam in Palo Pinto County, Texas, and were collected from January, 1995, to March, 1997. A recent description of this site can be found in Houghton and Stewart (1998a). Additional specimens were examined from the Illinois Natural History Survey, Champaign, IL (INHS); Montana Entomology Collection, Bozeman, MT (MTEC); and the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM). Literature records, and databases from the California Academy of Sciences (CAS), Clemson University Arthropod Collection (CUAC), INHS, MTEC, Royal Ontario Museum (ROM), USNM, the University of Minnesota Insect Collection (UMSP), and the University of North Texas Insect Collection (UNT) were searched for the distribution of *C. cantha*.

Larvae and pupae were collected from rocks using soft-touch forceps and with a two-stage dip net with mesh sizes of 1.00 and 0.15 mm. Measurements for determination of larval instars were made with an Olympus Cue-2 Image Analyzer attached to an Olympus dissecting microscope. The length of the head capsule was measured from the anterior margin of the frons to the posterior margin of the coronal suture, and was plotted against the length of the prothoracic mid-dorsal ecdysal suture to determine instar size range and number (Daly

1985). Larval illustrations were based on these measurements. Larvae and pupae were reared in an aerated 20 L aquarium with a MaxiFlow MJ500 power head providing current within an Environmental Growth Chamber to associate the life stages using the metamorphotype method (Milne 1938), and to obtain adults.

Larvae, pupae, and cases of *C. cantha* were studied and illustrated using a drawing tube attached to a Wild M2A dissecting microscope and slide mounts of specimens viewed under an Olympus CH2 compound microscope. Individuals were prepared for illustration by soaking overnight in 10% KOH and by blowing out any degraded viscera with an abdominal EtOH injection (Moulton and Stewart 1996). Voucher specimens of all life stages have been deposited in the UNT and the USNM.

Culoptila cantha (Ross)

Protoptila cantha Ross 1938: 113.
Culoptila cantha: Schmid 1982: 24.

Type locality.—Wyoming: Carbon Co (= Parco), North Platt R.

Nearctic distribution (Fig. 1). —UNITED STATES: ARIZONA: Maricopa Co: Sycamore Cr. (ROM); Coconino Co: nr. Flagstaff, Oak Cr. (INHS); Mohave Co. nr. Hackberry (USNM); Pinal Co: nr. Superor (INHS); Yavapi Co: Clear Cr. (USNM), Beaver Cr., Beaverhead Sp., Fossil Cr., Hassayampa R., Josephine Tunnel Sp., Oak Cr., Page Sp., Sycamore Cr., Red Tank Dr., Verde R. (INHS); COLORADO: Archulata Co: Piedra R. (ROM); Jackson Co (Ruiter 1990); Mesa Co: Colorado R. (Herrmann et al. 1986, USNM); Moffat Co: Yampa R. (Herrmann et al. 1986, USNM); IDAHO: Canyon Co: Boise R. (Ross 1938); Franklin Co: Bear R. (CAS); MARYLAND: Montgomery Co: Plummer's Island (Ross 1938); MAINE: Aroostook Co: Black R. (USNM), nr. Ashland (CAS); Franklin Co: Carrabassett R. (Blickle and Morse 1966); MONTANA: Gallatin Co: Madison R. (CAS, USNM); Madison Co: Madison R. (MTEC); NEW MEXICO: Catron Co: nr. Glenwood, Whitewater Cr. (INHS); Taos Co: Rio Grande R. (USNM); OKLAHOMA: Marshall Co: nr. L. Texoma (INHS); PENNSYLVANIA: Bradford Co: Susquehanna R. (INHS); SOUTH DAKOTA: Custer Co: Hot Springs Cr. (CAS); TEXAS: Bell Co (S. R. Moulton II, personal communication); Blanco Co: Pedernales R. (INHS); Brewster Co (S. R. Moulton II, personal communication); Cooke Co: Williams Cr. (K. D. Alexander, personal communication); Denton Co: Hickory Cr. (UNT); Kimble Co: S. Llano R. (S. R. Moulton II, personal communication); Medina Co: Medina R. (USNM); Palo Pinto Co: Brazos R. (Moulton et al. 1993); UTAH: Summit Co: (R. W. Baumann, personal communication); Washington Co: Mill Cr. (CAS); Uintah Co: Green River (ROM); WYOMING: Carbon Co (= Parco): N. Platte R. (Ross 1938); Converse Co: N. Platte R. (Ruiter and Lavigne 1985); Natrona Co: N. Platte R. (Ruiter and Lavigne 1985); Platte Co: N. Platte R. (Ruiter and Lavigne 1985), Bluegrass R. (CAS); Teton Co: Yellowstone National Pk. (Schmid 1982, CAS). CANADA: NEW BRUNSWICK: nr. Fredricton (CAS); St. Croix R. (Peterson and van Eeckhaute 1990); SASKATCHEWAN: S. Saskatchewan R. (Schmid 1982).

Pupa (Fig. 2).—Male and female pupae 2.5–3.0 and 4.0–5.5 mm, respectively, in body length. Mandible with large preapicomesal tooth and many smaller, basomesal teeth; two setae laterally near base. Two setae below each eye and near each mandibular base. Labrum dome-shaped; three setae arising basally on each side. Pair of anteromesal hook plates on segments III–VIII, segment IV with additional pair of posteromesal hook plates. All anterior hook plates similar in structure except hook plates on segment III each with 5–6 denticles, all others with 7–10 denticles. Posterior hook plates on segment IV wider, each with 12–16 denticles. Abdomen without setae, setal fringes, or anal processes.

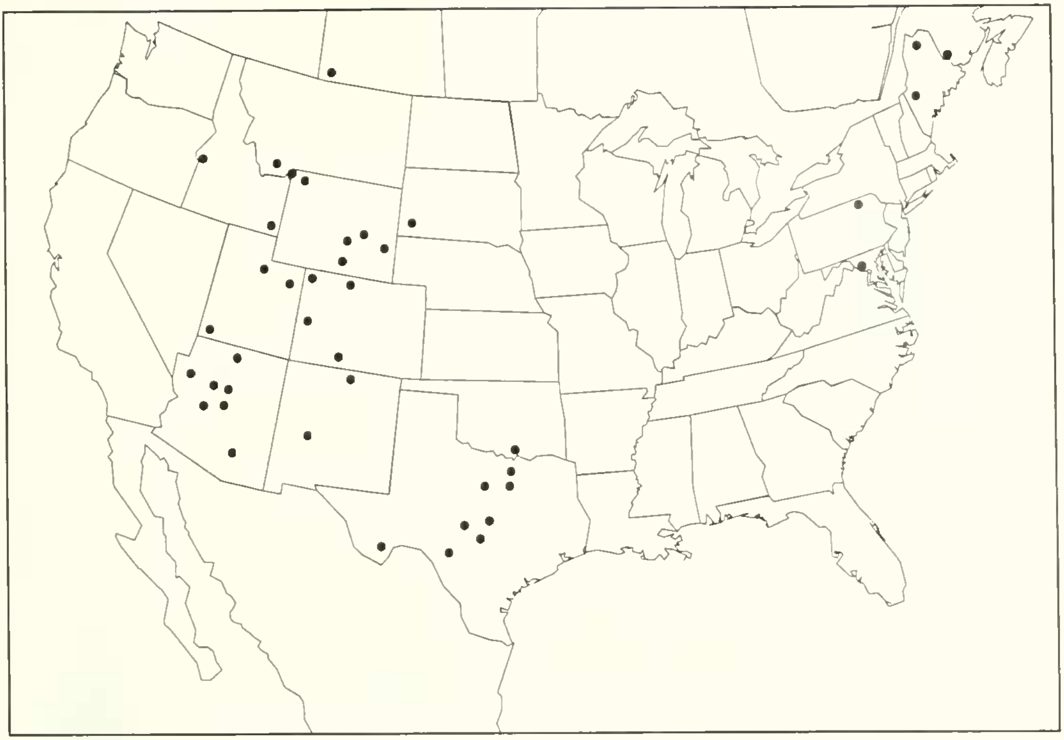

Fig. 1. Nearctic distribution of *Culoptila cantha*. Each dot represents the county and approximate location of a listed record.

Larva.—Five instars; relative sizes indicated by scale on Figs. 3, 4 (see Houghton and Stewart 1998a for precise size ranges). First and second instars obtained only in fine mesh of two-stage dip net and not within cases.

Instar I (Fig. 3A): Setae, legs, and anal prolegs long compared to major body segments. Head and thorax disproportionally larger than abdomen. Meso- and metanota unsclerotized. Tarsal claws without setae. Anal claws similar to those of later instars.

Instars II—IV (Figs. 3B–D): Exhibiting general *Culoptila* characteristics (Wiggins 1996a). Morphological changes largely matter of proportion in successive instars; legs, anal prolegs, and setae decreasing in size relative to body segments, abdomen increasing in size relative to head and thorax, and sclerites and pigment patterns becoming more evident.

Instar V (Fig. 4): Typical of Protoptilinae (Wiggins 1996a), 2.5–3.0 mm in body length, with retractable anal papillae. Live color pale red with black sclerites; cream color with brown sclerites when preserved in EtOH. Two types of thoracic setae present: slender, darkly-pigmented typical setae, and very slender, translucent setae. (Translucent setae and attachment points best viewed on slide mount of cleared specimen under compound microscope.) Live late fifth stadium prepupae darker red in color, less active than earlier fifth stadium, and with shortened, thickened abdomen.

Head (Figs. 4A–C): Dark brown with lighter dorsum and ocular areas. Frontoclypeus with shallow and broad anteromesal notch; three setae arising from each tentorial region. Scattered setae of various lengths around each eye. Three setae arising from each side of anterior margin of labrum. Many short setae on dorsal surface of labium. Venter of head capsule brown

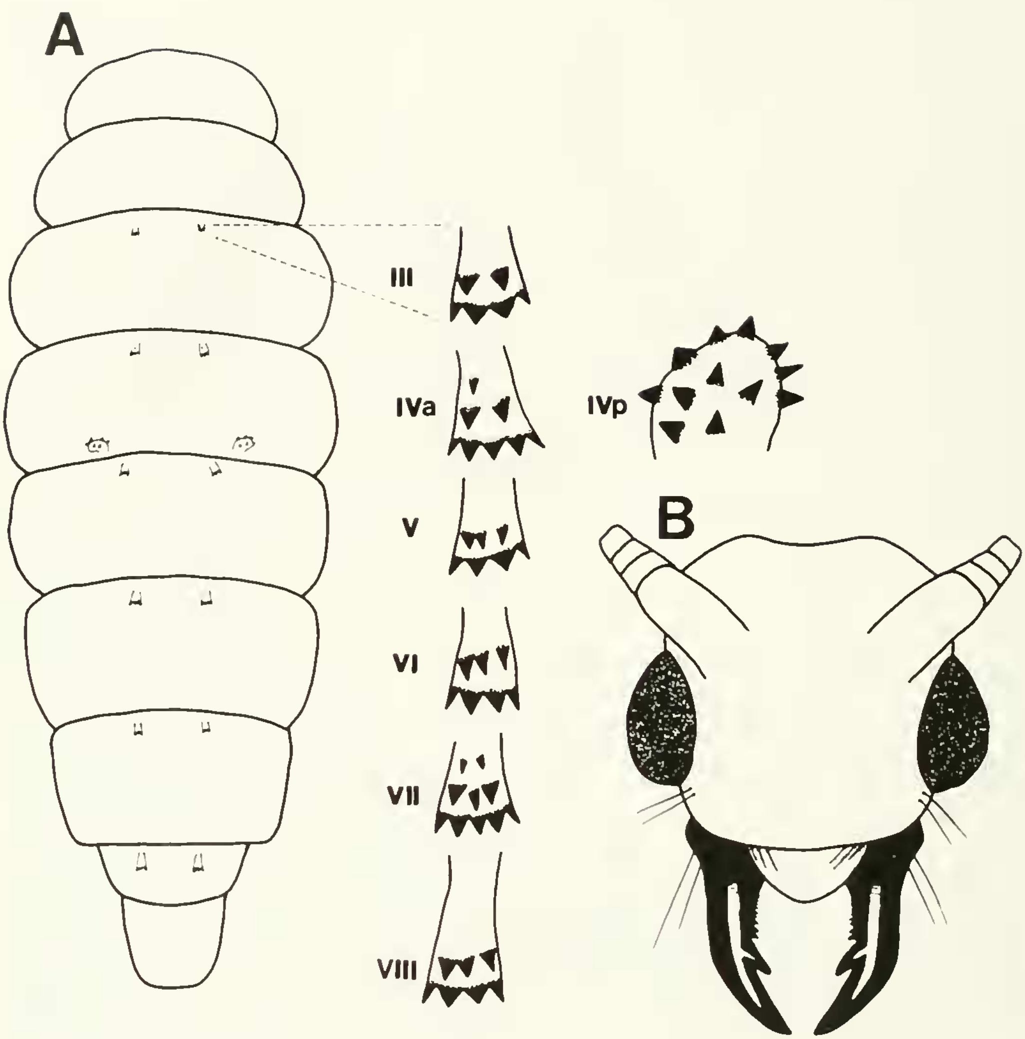

Fig. 2. *Culoptila cantha*, pupa. A, Abdomen with magnified detail of hook plates of each segment (dorsal). B, Head capsule with mandibles, antennal bases, and setal arrangement (antero-dorsal). III–VIII = hook plates of respective abdomenal tergum; a = anterior; p = posterior.

with two longer than broad triangular mental sclerites, each bearing single seta.

Thorax (Figs. 4A, C): Pronotum heavily sclerotized, dark brown, with anterior one-third markedly lighter than posterior two-thirds. Posterior often, but not always, with 2–6 light spots. Midlateral regions each with darkened area. Four and two setae arising from each anterolateral and midlateral region, respectively. One typical and one translucent setae arrising from posterolateral region. Two typical setae and one translucent seta on either side of mid-dorsal ecdysial suture on posterior one-third of pronotum. Mesonotum largely membranous, with one large mesal and two smaller lateral sclerites; sclerites lightly sclerotized and fading over time in EtOH causing inconsistent determination of shape among individuals. Mesal sclerite longer than wide, sinuosly bi-emarginate anteriorly, and evenly rounded posteriorly. Lateral sclerites sub-triangular, each with posteromesal notch. SA1 each with one typical and one translucent seta. SA2 setae absent. SA3 each with single typical seta. Metanotum largely membranous with pair of sub-triangular lateral sclerites. SA1 each with single translucent seta. SA2 and SA3 each with single typical seta. Foretrochantin hook-like, bearing two setae. Meso- and metathoracic episternal sclerites each with single seta. Legs similar in length and shape with major setae on all leg segments except trochanters. Apicoventral margin of each tibia with stout spur. Tarsal claws similar and typical of genus (Wiggins 1996a), each with stout basal seta much shorter than claw and basal process shorter than adjacent basal seta.

Abdomen (Fig. 4A): Shape typical of family (Wiggins 1996a). Segments I–V with one pair of dorsal, ventral, and lateral setae. Segments VI and VII each with one pair of dorsal and lateral setae. Segment VIII with two pairs of dorsal setae, two pairs of lateral setae, and one pair of ventral setae. Tergite IX with two pairs of setae arising laterally and medially. Lateral sclerites appearing fused to ventral sole plates, each bearing four setae. Anal claws with three hooks and two short setae.

Case.—Third through fifth instar larvae found in typical glossosomatid saddle-cases composed of small inorganic particles. Cases without the peripheral silk collars found on *Culoptila moselyi* cases (Wiggins 1996a) (Figs. 5A, B). Case lengths (n = 15 each) of third, fourth and fifth instars 2.0–2.5 mm, 2.5–3.0 mm and 3.5–4.5 mm, respectively; approximate particle sizes 0.1–0.50 mm, 0.25–1.0 mm and 0.5–2.0 mm, respectively. All larval cases of similar shape; some with approximately uniform particles (Type I) (Fig. 5A), and others with one or two larger side stones (Type II) (Fig. 5B).

Egg.—Obtained from live females, bright orange; 0.2 mm in diameter. Gravid females with three to six spherical masses with 15–20 eggs in each mass. Each egg mass enclosed in gelatinous covering. Soft and amorphic, without a distinct chorion.

Discussion

Larva.—We were unsuccessful in incubating eggs obtained from live *C. cantha* females. Therefore, first instars were not positively correlated by rearing. Presumed first instars were obtained only in the fine mesh of the two-stage dip net samples. They were abundant following peak *C. cantha* emergence and before the appearance of later instars, and they formed a distinctive size class (Fig. 3). They displayed the glossosomatid characteristics of largely membranous meso- and metanota, a tergal sclerite on segment IX, a single metanotal SA3 seta, and anal prolegs broadly joined to the abdomen. The only other glossosomatid known to occur at this site, *Protoptila alexanderi* Ross, appears to be univoltine with late instar larvae occurring only in July (Houghton and Stewart 1998b).

First and second instar larvae of *C. cantha* were never found in cases. Two possible explanations for this are: (1) first and second instars are free-living or (2) the kick-netting procedure may have destroyed all early instar cases or caused the larvae to vacate them. It is not probable that kick-netting would have demolished all small cases if they had been present, and no crushed early instar larvae were found in crushed cases. Anderson and Bourne (1974) found that *Agapetus bifidus* Denning constructed cases as first instars.

Third through fifth instars key to *Culoptila* using Wiggins (1996a). It appears that Wiggins' (1977, 1996a) character of "tarsal claws with basal seta stout, larger than process at base of claw" is diagnostic for the United States species. *Culoptila cantha* differs from Wiggins' (1977, 1996a) description of *C. moselyi* mainly in the placement of pronotal setae.

Pupa.—Both male and female pupae key to Glossosomatidae using Wiggins (1996b) although the final couplet: "Segments VIII and/or IX with pair of *small* hook plates . . ." (emphasis ours) is slightly misleading. The hook plates of *C. cantha* on segment

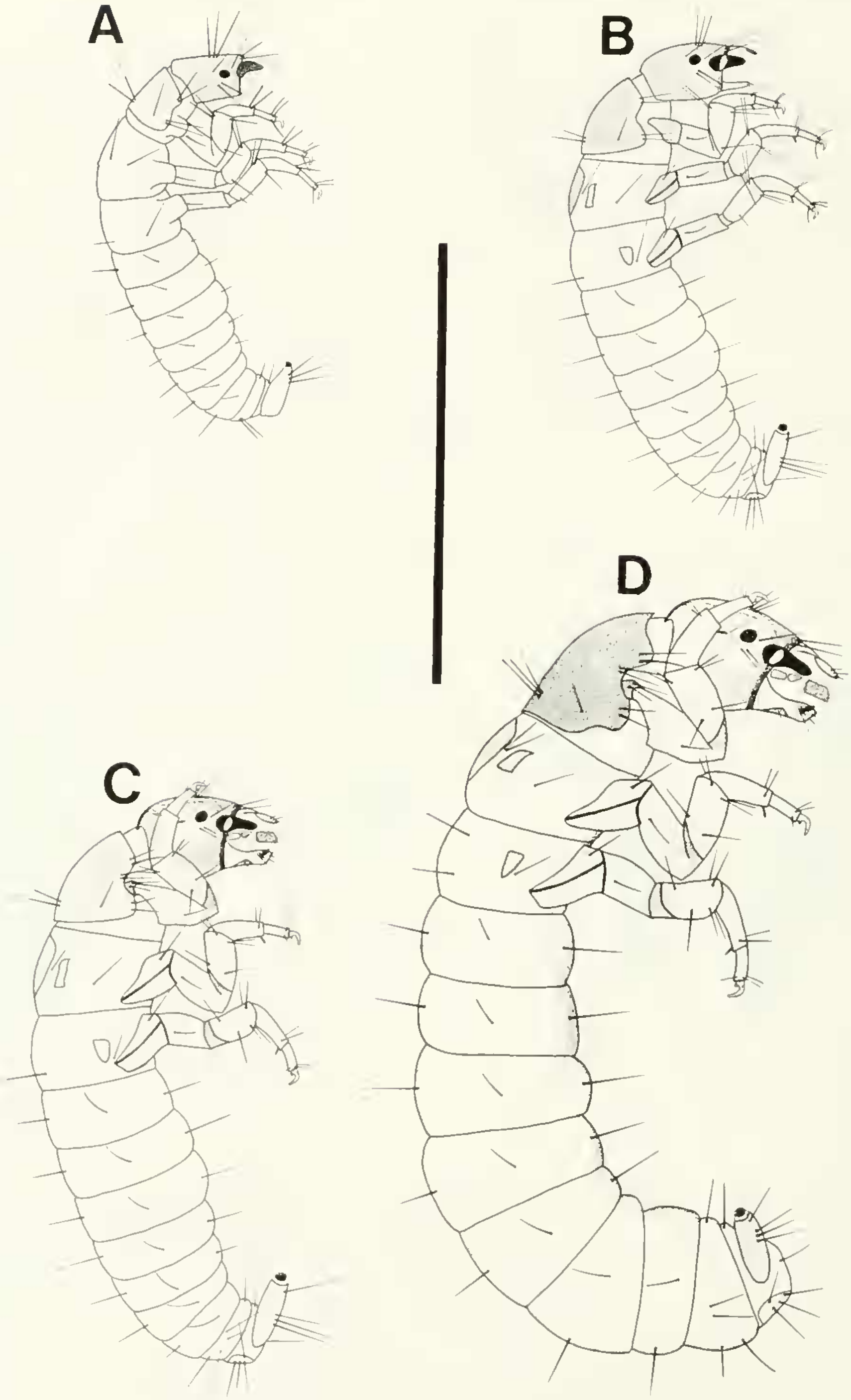

Fig. 3. Instars I–IV of *Culoptila cantha*; relative habitus size based on mean prothoracic length. A, First instar. B, Second instar. C, Third instar. D, Fourth instar. Scale bar = 1 mm.

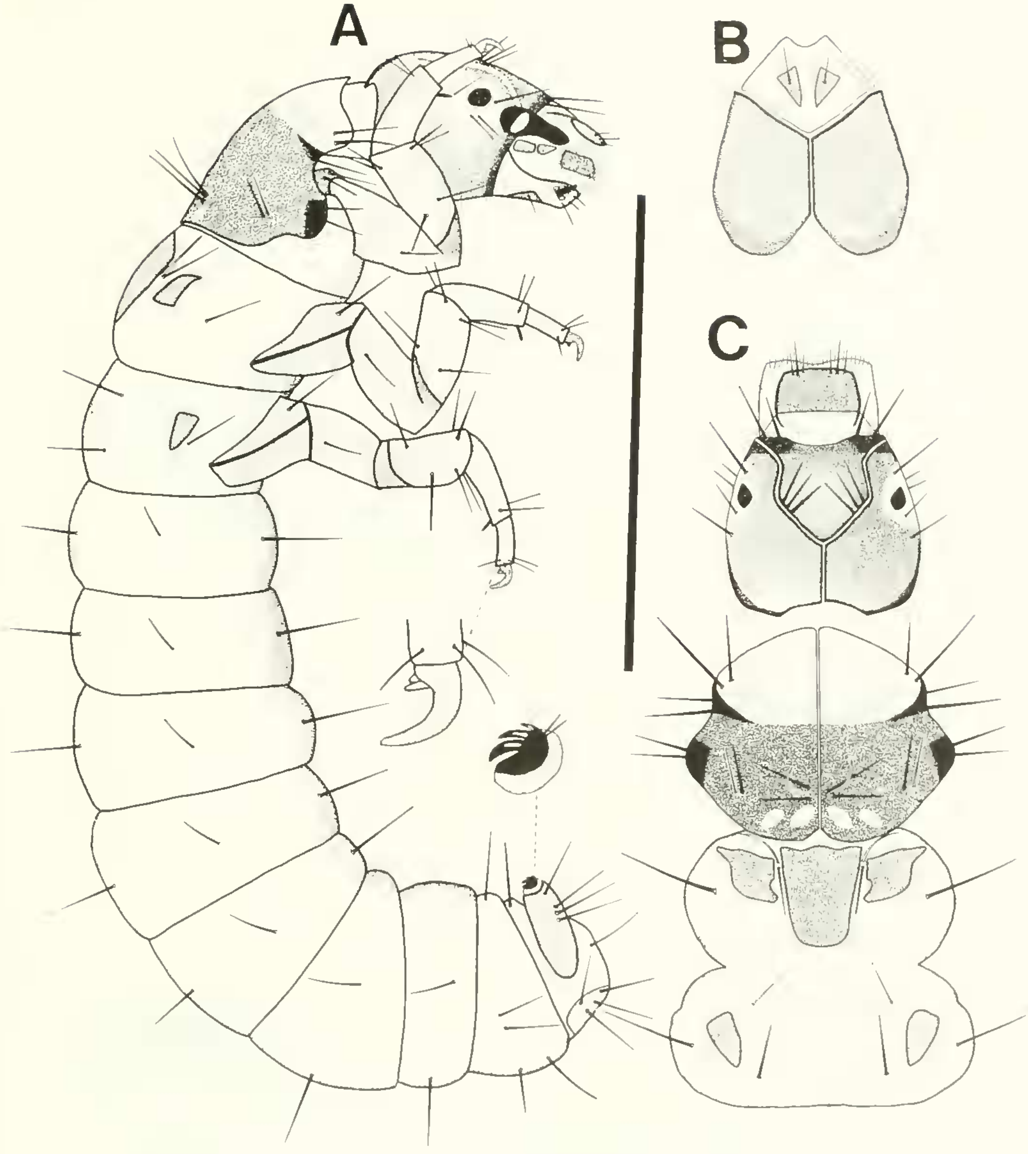

Fig. 4. *Culoptila cantha*, fifth instar; relative size based on mean prothoracic length. A, Habitus, with detail of mesothoracic claw and anal prolegs. B, Head capsule (ventral). C, Head and thorax (dorsal). Scale bar = 1 mm.

VIII are slightly longer than those of the preceeding segments and it does not have a pair on segment IX. The abdomen of *C. cantha* differs from previous glossosomatid pupal descriptions (Wiggins 1996b, Craft and Morse 1997) in that it lacks setae.

The pupa of *C. cantha* also differs in the finer details from previous descriptions within its subfamily Protoptilinae. It differs from Edwards and Arnold's (1961) description of *Protoptila arca* Edwards and Arnolds in having a pair of setae near each mandibular base, and from Ross' (1944) description of *Protoptila lega* Ross in having many basomesal teeth notably smaller than the preapicomesal tooth and in its preapi-

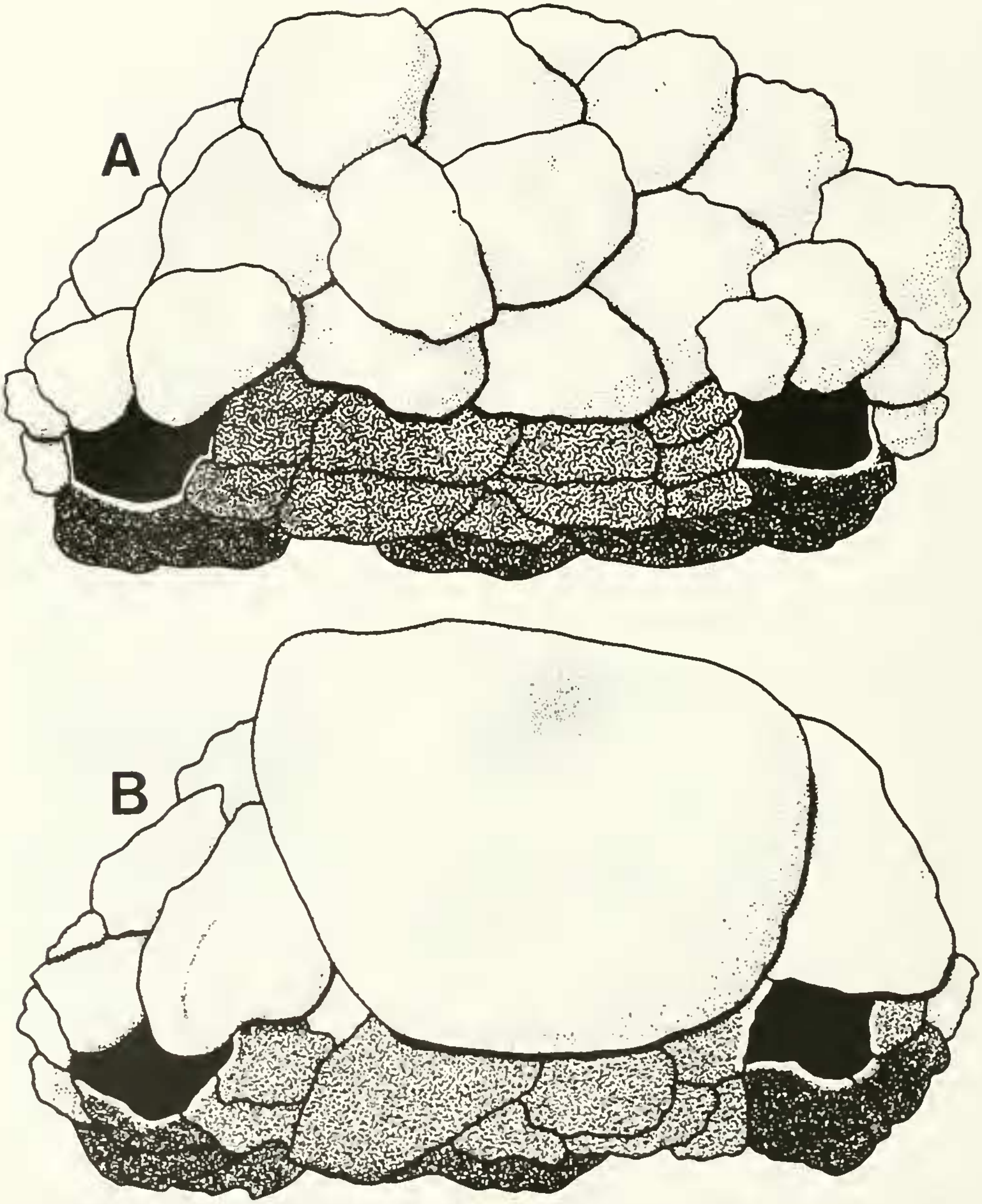

Fig. 5. Variation in *Culoptila cantha* cases. A, Field-collected Type I case with uniform substrate composition (ventrolateral). B, Field-collected Type II case with large side stones (ventrolateral).

comesal tooth being considerably shorter than its apical tooth. Neither of these descriptions included the pupal abdomen. It differs from Flint's (1962) description of *Matrioptila jeanae* (Ross) in having hook plates on segment VIII, a wider posterior hook plate on segment IV, and in lacking an "anterior setal group" on either side of the labrum. Its mandibles, however, look similar to those of *M. jeanae*.

Case.—Wiggins (1996a) described *C. moselyi* cases as being composed of small uniform inorganic particles, and indicated that this attribute could be used to separate larvae of *Culoptila* from *Protoptila*, whose cases have two large side stones. The Type I and II cases of *C. cantha* (Fig. 5) indicate that the uniformity of case particles is not a good character for separating these two genera. Often a *C. cantha* larva found in one type of case in the field made the other type case after forced removal and placement in an aquarium. Many individuals with different case types were reared to the adult stage and were confirmed as *C. cantha*. *Protoptila alexanderi* was found in small numbers at the Brazos River site, and after examining a series of 12 late instar cases, we were unable to separate them from the variable *C. cantha* cases.

Distribution.—*Culoptila cantha* is distributed throughout the western U.S., with isolated populations in the northeastern U.S. (Fig. 1). The type locality and many other reported collecting localities were in large river habitats with circumneutral pH (Ross 1938, Peterson and van Eeckhaute 1990, Moulton et al. 1993, Wiggins 1996a). However, some adults have been caught near spring habitats in Arizona and at two intermittent northern Texas streams (Fig. 1). Herrmann et al. (1986) reported *C. cantha* from an altitudinal range of 1494–1801 m in Colorado. It has not been reported from the Neotropics (R. W. Holzenthal, J. Bueno-Soria, personal communications).

The apparent absence of *C. cantha* from the central and southeastern U.S. despite heavy collecting at least in the Southeast (e.g. Etnier and Schuster 1979; Harris et al. 1991; J. C Morse, personal communication) is difficult to explain without a better understanding of *Culoptila* phylogeny. *Culoptila thoracica* has been reported from North Carolina (Flint 1974). Some other Nearctic species of Trichoptera exhibiting disjunct distributions include *Marilia flexuosa* Ulmer (Odontoceridae) and *Neotrichia collata* Morton (Hydroptilidae); the former occurs throughout the American Southwest and Interior Highlands, and has been recorded from Vermont and Ontario; the latter is found in the eastern U.S. with a population in Utah (B. J. Armitage, personal communication; Moulton and Steward 1996).

Material Examined

ARIZONA: Yavapai Co., Clear Cr. Cmp., SE Camp Verde, 17-VI-68, Flint and Menke, 1 ♂, 4 ♀♀ (USNM). COLORADO: Moffat Co., Yampa R., below Maybell, 03-VIII-73, R. W. Baumann and A. Brower, 13 ♂♂, 19♀♀ (USNM). MONTANA: Madison Co., Madison R., Norris, Drift, 27-VI-1978, unknown collector, 5 ♂♂ (MTEC). PENNSYLVANIA: Bradford Co., Susquehanna River, nr. Athens, 05-VIII-1937, J. H. Eddleson, 2 ♂♂, 2 ♀♀ (INHS). SOUTH DAKOTA: Custer Co., Hot Springs, Hot Springs Ck., unknown collector, 8 ♂♂ (MTEC). TEXAS: Cooke Co., Williams Creek, 11 km W. Era, 10-IV-1996, K. D. Alexander, 1 ♂; same except 09-X-1996, 1 ♂; Denton Co., Hickory Creek, nr. Water Research Field Station, 24-VI-1994, R. J. Currie, 1 ♂ (UNT); Palo Pinto Co., Brazos River at Route 4 Br., 10 km SE Graford, 21-I-1995, D. C. Houghton, 14 larvae, 3 ♂ metamorphotypes, 2 ♀ metamorphotypes; same except 20-IV-1995, 12 larvae, 14 pupae, 6 ♂ metamorphotypes, 4 ♀ metamorphotypes; same except 14-X-1995, 12 pupae; same except 10-II-1996, 21 larvae; same except 15-III-1996, 13 larvae, 17 pupae; same except 15-III-1996, 9 larvae, 14 pupae.

Acknowledgments

The authors thank the following institutions and individuals for providing additional collecting records and lending *C. cantha* specimens: K. D. Alexander, R. W. Baumann, R. J. Currie, S. R. Moulton II, the CAS (V. F. Lee), the INHS (K. R. Zeiders), the MTEC (M. A. Ivie), the ROM (D. Currie), and the USNM (N. E. Adams and O. S. Flint, Jr.). We thank the following people for assisting us in the field and laboratory: J. C. Abbott, G. L. Akin, R. G. Jones, C. J. Larsen, J. C. Norwood, S. A. Peterson, J. P. Snow and N. L. Witt. The comments of J. H. Kennedy, S. R. Moulton

II, and two anonymous reviewers improved earlier versions of the manuscript.

Literature Cited

Anderson, N. H., and J. R. Bourne. 1974. Bionomics of three species of glossosomatid caddisflies (Trichoptera: Glossosmatidae) in Oregon. Canadian Journal of Zoology 52:405–411.

Blickle, R. L., and W. J. Morse. 1966. The Caddisflies (Trichoptera) of Maine, excepting the family Hydroptilidae. Maine Agricultural Experimental Station Technical Bulletin 24: 1–12.

Craft, J. S., and J. C. Morse. 1997. The larva, pupa and female of *Agapetus jocassee* Morse (Trichoptera: Glossosomatidae). Journal of Entomological Science 32:377–385.

Daly, H. V. 1985. Insect Morphometrics. Annual Review of Entomology 30:415–438.

Edwards, S. W., and C. R. Arnold. 1961. The caddis flies of the San Marcos River. The Texas Journal of Science 13:393–415.

Etnier, D. A., and G. A. Schuster. 1979. An annotated list of Trichoptera (caddisflies) of Tennesee. Journal of the Tennesee Academy of Science 54: 15–22.

Flint, O. S., Jr. 1962. The immature stages of *Matrioptila jeanae* (Ross) (Trichoptera: Glossosomatidae). Journal of the New York Entomological Society 70: 64–67.

———. 1974. The Genus *Culoptila* Mosely in the United States, with two new combinations (Trichoptera: Glossosomatidae). Proceedings of the Entomological Society of Washington 76: 284.

Harris, S. C., P. E. O'Neil, and P. K. Lago. 1991. Caddisflies of Alabama. Geological Survey of Alabama, Bulletin 142. Tuscaloosa, AL. 442 pp.

Herrmann, S. J., D. E. Ruiter, and J. D. Unzicker. 1986. Distribution and records of Colorado Trichoptera. Southwestern Naturalist 31: 421–457.

Houghton, D. C., and K. W. Stewart. 1998a. Life history and case-building behavior of *Culoptila cantha* (Trichoptera: Glossosomatidae) in the Brazos River, Texas. Annals of the Entomological Society of America 91:59–70.

———. 1998b. Seasonal flight periodicities of six microcaddisflies (Trichoptera: Hydroptilidae, Glossosomatidae) in the Brazos River, Texas with notes on larval biology and site records. Entomological News 109: 103–109.

Milne, M. J. 1938. The "metamorphotype" method in Trichoptera. Journal of the New York Entomological Society 46: 435–437.

Moulton II, S. R., and K. W. Stewart. 1996. Caddisflies (Trichoptera) of the Interior Highlands of North America. Memoirs of the American Entomological Institute 58: 1–313.

Morse, J. C. (In Prep.) Checklist of World Trichoptera. Clemson University Homepage, World Wide Web. http://biowww.clemson.edu/Ento/databases/trichoptera/trichintro.html/

Peterson, R. H., and L. van Eeckhaute. 1990. Distributions of Stonefly (Plecoptera) and Caddisfly (Trichoptera) species in three stream systems in New Brunswick and Nova Scotia, Canada, with reference to stream acidity. Canadian Technical Report of Fisheries and Aquatic Sciences 1720:iii + 42 pp.

Ross, H. H. 1938. Descriptions of Nearctic caddis flies (Trichoptera) with special reference to the Illinois species. Bulletin of the Illinois Natural History Survey 21: 101–183.

———. 1944. The caddisflies, or Trichoptera, of Illionois. Bulletin of the Illinois Natural History Survey 23: 1–326.

Ruiter, D. E. 1990. A new species of *Neotrichia* (Trichoptera: Hydroptilidae) from Colorado with additions and corrections to the distribution and records of Colorado Trichoptera. Entomological News 101:88–92.

Ruiter, D. E., and R. J. Lavigne. 1985. Distribution of Wyoming Trichoptera. University of Wyoming Agricultural Experimental Station Publication 5 M 47: 102 pp.

Schmid, F. 1982. Revision des trichoptères canadiens. Les Glossosmomatidae et Philopotamidae (Annulipalpia). Mémoires de la Socíeté Entomologique du Canada 122: 76 pp.

Wiggins, G. B. 1977. Larvae of the North American Caddisfly Genera (Trichoptera). University of Toronto Press, Toronto, Ontario, Canada. 401 pp.

———. 1996a. Larvae of the North American Caddisfly Genera (Trichoptera), 2nd Edition. University of Toronto Press, Toronto, Ontario, Canada. 457 pp.

———. 1996b. Trichoptera families, pp. 309–359. *In* Merritt, R. W. and K. W. Cummins, eds. An introduction to the aquatic insects of North America. Kendall/Hunt, Dubuque, IA.